

A FEW THOUGHTS ABOUT HIGH ENERGY DETECTORS

F. Villa
Stanford Linear Accelerator Center

July 31, 1968

It seems evident that a considerable fraction of high energy experimentation at NAL will depend on spark chamber + magnets type of detector. At very high energies accuracy (for all sources of errors) is of the utmost importance. For example, a 5 M \$ instrument like the large streamer chamber can be reduced to a 4 M \$ instrument by decreasing the setting error from 560μ to roughly 400μ . The inherent accuracy or diffusion-limited accuracy of a streamer chamber (and, for the matter, of any spark-chamber device) is of the order of 200μ , even neglecting the effect of magnetic field containment of the primary ionization. We feel there are some areas of study, to be considered as an investment, by which the accuracy (overall setting error) might be reduced. We list them, with no regard to their relative size:

1. Magnetic field mapping. Typical accuracies (after fitting) in large magnets are, at present, of the order of 0.5%. With proper care and instrumentation the error should go down to 0.1% or less. It is expected, at least with conventional techniques, that the difficulty of measuring magnetic fields increases very rapidly with the volume of magnetic field to be mapped.

2. Study of limit accuracy of spark-chamber devices, and possible ways of getting close to the diffusion limited accuracy.

3. Study of very flexible, fast hard-wired electronics. The use of spark chambers is highly effective if rather complicated decisions can be taken in a short time (typically $500\mu\text{s}$). An interesting approach is in Ref. 1, starting from the observation that any function of logic variables can be expanded in series of AND or OR logic operators.

4. Vidicons or other scanning electronic devices are still insufficiently accurate and distortionless. Specifications should be set and different industries should be triggered to improve these devices. For film spark chambers, films with better acutance, better dimensional stability, better resolution and sensitivity should be developed. A typical example is the film SO-340, specially developed for SLAC by Kodak. It is a film with 1% quantum efficiency (100 photons in the red orange region to make 1 grain 7μ in size) with a resolution of 70 lines/mm at 50% modulation, very high acutance and excellent latitude of exposure. The possibility of using only one kind of film for spark chambers, wide gap and streamer chambers will save a considerable amount of money (also called the McNamara principle, well known not to work in aviation).

5. Development and application of very accurate instruments for determining missing neutral energies (γ , n). Total absorption Cerenkov or NaI (Tl) counters have been proved accurate up to 1% at 10 GeV electron or photon energies. The same devices seem very promising for

determining hadron energies (Refs. 2 and 3). An ideal instrument for measuring both energy and angle of π^0 's would be a spark chamber with plates made of lead fluoride, where each plate is viewed by photomultipliers to determine the total energy and the angles are measured by the first e.m. interaction in the plates. This technique leads to an ambiguity in the π^0 direction; however, if the γ -ray separation in space is larger than the radial spread of the shower, sampling techniques to remove this ambiguity may be feasible.

6. There are two different techniques so far used to evaluate the size and parameters of a high energy events detector: The first calculates maximum allowable errors on single prongs, to distinguish no missing neutral from 1, 2, etc. missing neutrals, using only kinematical formulae. The second generates FAKE input data (i.e. what one would measure on film or an on-line computer output) and fits the event with a reasonable setting error. The two techniques do give two different answers, and this is not surprising since the use of correlation among tracks (in the second technique) shrinks both angular and momentum errors. Both techniques have advantages and disadvantages, and I feel that additional study is necessary to set criteria in the design of high energy event detectors.

REFERENCES

- ¹E. Schiavuta and F. Soso, Proposal for a New Organization of Decision Electronics in Multicounter Experiments, Nucl. Instr. and Methods, 60, 36 (1968).
- ²W. A. Lakin et al., HEPL 551, Feb. 1968.
- ³R. Hofstadter, HEPL 556, March 1968.